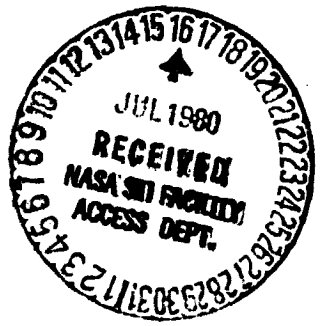
NASA TECHNICAL MEMORANDUM NASA TM-75944

CHANGES IN LEUKOCYTE STABILITY IN HYPODYNAMIA

I. I. Federov and Z. P. Federova,
Ye. N. Pekus and T. L. Sakun

Translation of "Izmeneniye stoykosti leykotsitov pri gipodinamii", Vrachebnoye Delo, April 1972, pp 44-48



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D. C. 20546 January, 1980

STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-75944		

4. Title and Subtitle	5. Report Date
Changes in Leukocyte Stability in Hypodynamia	January, 1980
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
I. I. Federov and Z. P. Federova, Ye. N. Pekus and T. L. Sakun	10. Work Unit No.
	11. Contract or Grant No. NASw- 2791
9. Performing Organization Name and Address SCITRAN Box 5456 Santa Barbara, CA 93108	13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546	14. Sponsoring Agency Code

15. Supplementary Notes

Translation of "Izmeneniye stoykosti leykotsitov pri gipodinamii", Vrachebnoye Delo, April 1972, pp 44-48

16. Abstract

Leukocytolysis (after I. I. Federov's technique) was determined under conditions of hypokinesia of 10 days to 1 month duration in healthy persons and in experiments on albino rats of 1 month duration.

It was found that prolonged restriction of movement resulted, both in clinical and experimental conditions, in a considerable increase of leukocytolysis (by two-three-fold). Leukocytolysis continued several days after cessation of hypokinesia.

17. Key Words (Selected by Author(s))	18. Distribution Statement
	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	8	

UDC 616.155.3-008.1.07:612.766.2

CHANGES IN LEUKOCYTE STABILITY IN HYPODYNAMIA

by
I. I. Fedorov, Z. P. Fedorova, Ye. N. Pekus, and T. L. Sakun, Kiev Institute for Advancement of Physicians and Kiev Scientific Research Institute of Medical Problems of Physical Culture

Leukocytolysis (after I. I. Fedorov's technique) was determined under conditions of hypokinesia of 10 days to 1 month duration in healthy persons and in experiments on albino rats of 1 month duration.

It was found that prolonged restriction of movement resulted both in clinical and experimental conditions in a considerable increase of leukocytolysis (two-three-fold). Leukocytolysis continued several days after cessation of hypokinesia.

Experimental and clinical study of leukocytolysis, from whose state one can judge the resistance of the organism, is of great importance in prolonged hypokinesia. /44*

Limited human motor activity is a defense measure of the organism in many diseases (various forms of cardiovascular pathology, affection of the nervous system, certain types of trauma, etc.). However, prolonged hypodynamia results in unfavorable shifts in the organism. A rigid pattern of hypodynamia can also accompany space flights. In light of the aforementioned, hypodynamia becomes a most important problem of medicine requiring serious study.

The state of hypodynamia in experiment was attained by placing

*Numbers in margin indicate pagination in original foreign text.

the experimental animals (50 albino rats, males, weighing 200-250 g) in especially designed cages whose dimensions considerably limited their mobility. The duration of hypokinesia was 30 days. The blood for studying the animals was taken from the major vessels. The control was healthy rats of the same age, sex and weight maintained under normal conditions of a vivarium on the same food ration as the experimental rats.

In this work the degree of leukocytolysis was determined according to a technique developed in the department of the laboratory of diagnostics of the Kiev Institute for the Advancement of Physicians. The proposed technique has a number of advantages, and precisely: to obtain a leukocyte concentrate small quantities (0.4 ml) of blood are used which can be easily taken from the finger, human ear lobe, as well as from any region of the animal body; the concentration of leukocytes is reached with the help of a spiral centrifuge TsS-1 whose use accelerates and simplifies the method of preparing the leukocyte concentration. One should also note that in the leukocyte concentrate obtained with the help of the TsS-1 concentrate the leukocytes undergo little trauma, since during the centrifuging the blood is located in an elastic, plasticized capillary and not subject to chemical effect. The determination of the degree of leukocytolysis according to the suggested technique requires a little over an hour, while the use of other methods occupies a day and more.

The leukocyte concentrate obtained with the help of the spiral centrifuge is diluted with a physiological solution and incubated for one hour in an incubator at temperature of 37°. The total quantity of leukocytes in 1 mm^3 of concentrate before and after the incubation is computed by the standard chamber method with the use of a blender. To determine the degree of leukocytolysis the percentage of leukocytes destroyed during the incubation is computed. The proposed technique was approved in experimental and clinical conditions. According to the data of the authors, the degree of leukocytolysis in the albino rats is $10\pm3\%$, and in practically healthy, adult people--$13.5\pm1.7\%$.

The findings indicated that leukocytolysis of intact albino rats fluctuated in limits 8.0±1.2%.

As follows from the findings, in limited motor activity the stability of the leukocytes in rat blood was reliably reduced. Thus, whereas in the animals . . the control group leukocytolysis was on the average 8.0±1.2%, in rats who underwent prolonged hypokinesia leukocytolysis rose by more than three-fold and was 25.4±2.2%.

Especial attention in the work was given to a study of the stability of leukocytes in people who spent a long time confined to bed with maximum limitation of the muscular activity. The study was made in May-June 1970 under clinical conditions. Six practically healthy young people were under observation; a thorough and comprehensive examination was made of them in the initial state before the beginning of the experiment, in a normal motor pattern.

Further three of them (P-s, K-r and Ye-n) were kept for 30 days under /45
special conditions of strict bed confinement with limited motor activity, the remaining three (T-n, Kh-oy and K-iy) were in a state of hypokinesia for 10 days.

The degree of leukocytolysis was determined in dynamics according to the technique indicated in the experimental section. The results from determining leukocytolysis in people are given in the table.

Determination of the degree of leukocytolysis in dynamics during hypokinesia demonstrated that a reduction in the stability of leukocytes occurs already on the 10-14th day, whereby in half of the subjects at this time leukocytolysis was increased two-fold as compared to the initial, and in the others--somewhat less. It is important to note that the process of intensified breakdown of leukocytes continued for several days even after the end of hypokinesia. Thus, in one of the six subjects in a week and in one of them in two weeks after the end of hypokinesia the stability of the leukocytes approached the initial values, and in all the others--leukocytolysis in the beginning (1-2 weeks) of the restorative period remained

TABLE

Subjects	Initial amounts	In 10-14 days after start of hypokinesia	In a month after start of hypokinesia	In 2 weeks after end of hypokinesia
P-s	18.0	35.8	54.5	49.2
K-r	10.3	29.3	18.0	11.2
K-n	14.0	20.2	24.8	22.2
				Within a week after the end of hypokinesia
K-iy	8.0	11.0	-	44.0
K-oy	9.0	22.0	-	33.3
T-n	18.0	31.6	-	20.0

high. An especially considerable intensification of leukocytolysis on the eighth day of the restoration period was noted in the subject K-iy, in whom, as is apparent from the data of the table, leukocytolysis in this time was 44%, which is five plus times greater than the initial level. It should be noted that in this subject the total leukocytosis in the peripheral blood was considerably reduced; before hypokinesia leukocytosis in him was 9100, on the 10th day of hypokinesia--6200 and a week after the end of hypokinesia--4600 leukocytes in 1 mm^3.

The findings on the reduction in stability of leukocytes during hypokinesia are linked to the changes in their functional state, in particular, with the change in the absorbing function of the neutrophils in the peripheral blood. With prolonged hypokinesia, after a short-term period of primary stimulation of phagocytosis a phase begins of lengthy suppression of the absorbing ability of the leukocytes (B. A. Chukhlovin, S. A. Burov, 1969). Under these conditions both the nonspecific anti-infection resistance and the specific immunological reactivity of the organism, and favorable conditions are created for intensification in the activity of the automicroflora, latent infection or spread of the stimulant brought from outside.

In several conditions of the experiment altered in technique we successfully clarified the definite effect of the plasma factors on the intensity of leukocyte breakdown. We incubated the leukocyte concentrate in an incubator not only with a physiological solution as provided for by

the technique, but parallel with the plasma of blood of other experimental animals. Here it was found that the magnitude of breakdown of leukocytes incubated in the physiological solution and in the blood plasma was different. Especially distinct differences were noted in the experiments of incubating the leukocyte concentrate of healthy rats with blood plasma of rats who had undergone hypokinesia and had a high percentage of leukocytolysis. Under these experimental conditions the breakdown of leukocytes of healthy rats considerably increased.

It is quite possible that under conditions of lengthy restricted mobility, as a result of the disruption in metabolic processes, in the blood plasma incompletely oxidized products of metabolism are accumulated and circulate, and the mean level of vacant-oxygen is increased in the blood and /46
in the urine (D. F. Chebotarev et al., 1969), and recovery of protein with the dominance of breakdown over synthesis is reduced (R. V. Chagovets, 1957; P. V. Gudz', 1968), and unfavorable conditions are created for the vital activity of the white blood cells.

According to our data, during restricted movement in the blood of the experimental animals the content of lactic and pyruvic acids increased. The lactate concentration in the blood of rats at the end of a month of hypokinesia reliably increased and rose 1.5-fold versus the initial amounts, while the content of pyruvate rose from 1.6 ± 0.07 to 2.4 ± 0.3 mg% ($D > 0.05$).

An increase in the concentration of the indicated substances can indicate, on the one hand, the intensification of glycolysis, and on the other, an increase in pyruvate and lactate in the blood can indicate the delay in oxidation and the processes of resynthesis into glycogen, and the reduction in intensity of the Pasteur-Meyerhof reaction. As was shown previously (I. I. Fedorov, 1958) an internally administered solution of lactate under conditions of normal functioning of the organism and in certain pathological processes is rapidly included in the metabolism, in the first place, in the biochemical processes occurring in the liver. Under conditions of hypokinesia the products of interstitial exchange of pyruvate and lactate are in increased concentrations and are included in the metabolic processes

insufficiently intensively.

Thus, one should note that lengthy restricted motor activity is accompanied by an increase in the percentage of leukocytolysis. A certain role in the increase of the degree of leukocytolysis during hypokinesia belongs to the biological properties of the blood plasma.

References

Gudz', P. Z. Arkhiv patologii, gistologii, embriologii, No. 7 (1963), p. 55.

Chagovets, R. V. in Trudy Kiyevskogo instituta fizicheskoy kul'turi ["Proceedings of Kiev Institute of Physical Culture"], Kiev, 1957, No. 2, p. 105.

Chebotarev, D . F.; Korkushko, O. V.; and Kalinovskaya, Ye. G. Materialy mezhdunarodnogo simpoziuma. Dvigatel'naya aktivnost' i stareniye ["Materials of International Symposium. Motor Activity and Aging"], Kiev, 1969, p. 213.

Chukhlovin, B. A.; and Burov, S. A. Probl. kosmicheskoy biologii ["Problems of Space Biology"], Moscow, 1969, p. 115.